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IS 12391 (1988): Iron nickel controlled expansion sealing alloys [MTD 16: Alloy Steels and Forgings]

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IS : 12391 - 1988

(Reaffirmed 2004)

Indian Standard

SPECIFICATION FOR IRON-NICKEL CONTROLLED EXPANSION SEALING ALLOYS

"Reference Copy-BIS-SJCE- STEP Standards Information Centre, Mysore

Special Alloys Sectional Committee, SMDC 33 [Ref : Doc : SMDC 33 (3350)]

1. Scope — Covers the requirements of 3 types (*see* Table 1) of wrought iron-nickel sealing alloys in the form of wires, rounds and strips intended primarily for sealing to glass and for other applications as mentioned in **1.1** and **1.2**. Tubings are not included under the scope of this specification.

1.1 FENI 42 and FENI 48 are intended for use as glass-to-metal seals in electron tubes, semiconductor lead frames and lead wires in the manufacture of relay components, automobile lamps, bi-metallic thermostats and for shielding applications.

1.2 FENI 50 finds application in glass-to-metal seals for higher than normal thermal expansion glass as well as for glass-to-ceramic seals where thermal expansion must be almost linear up to 550°C. It is also intended to be used in hermetically sealed magnetic dry reed relays and switches.

2. Supply of Material — The general requirements relating to the supply of this material shall conform to IS : 1387-1967 'General requirements for the supply of metallurgical materials (*first revision*)'.

3. Chemical Composition — The chemical composition of iron-nickel alloys, when determined by gravimetric or spectro-chemical analysis, shall be as indicated in Table 1.

TABLE 1 CHEMICAL COMPOSITION, PERCENT

(*Clauses* 1 *and* 3)

Elements	FENI 42	FENI 48	FENI 50
Nickel*, nominal	42	48	50
Carbon, *Max*	0·05	0·05	0·05
Manganese, *Max*	0·80	0·80	0·60
Silicon, *Max*	0·30	0·30	0·30
Chromium, *Max*	0·25	0·25	0·25
Phosphorus, *Max*	0·025	0·025	0·025
Sulphur, *Max*	0·025	0·025	0·025
Aluminium, *Max*	0·10	0·10	0·10
Cobalt, *Max*	†	†	†
Iron	Remainder	Remainder	Remainder

*The percentage of nickel indicated is only nominal and shall be adjusted suitably by the manufacturer so that the alloys meet the requirement of thermal expansion indicated in 7 and Table3.

†For special applications, cobalt content shall not exceed 0·02 percent or as agreed to between the purchaser and the manufacturer.

4. Finish

4.1 The iron-nickel alloys, FENI 42, FENI 48 and FENI 50, shall be supplied in any of the sizes and finishes indicated in Table 2 as stated in **4.2** and **4.3**.

4.2 *Lengths of Supply for Wires and Rounds*

Wires	Diameters 0·05 to 0·8 mm	In continuous length wound on spools, nett mass of wire not exceeding 1·5 kg
	Above 0·8 to 3 mm	In coils of continuous length of 10 to 50 kg mass
Rods	Diameters Above 3 to 10 mm Above 10 to 100 mm	1 to 3 metres Other lengths on specific request by the purchasers

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TABLE 2 FORMS OF SUPPLY, FINISHES AND SIZES

(*Clause* 4.1)

Form	Finish	Size
Wire	*Cold drawn* Cold drawn and annealed	Diameter 0·05 to 4·00 mm
Round	Cold drawn Cold drawn, ground Cold drawn, annealed Cold drawn, annealed and ground	Diameter Above 4 to 12 mm
	Hot rolled Hot rolled, peeled Hot rolled, peeled and centreless ground	Diameter Above 12 to 50 mm
	Hot rolled/forged Hot rolled, forged and turned	Diameter Above 50 mm
Strip	Cold rolled Cold rolled, annealed	Thickness 0·05 to 4 mm; and width 5 to 225 mm
Sheet	Cold rolled Cold rolled, annealed	Thickness 0·8 to 4 mm; width 1 000 mm, *Max*; and length 3 000 mm, *Max*

4.3 *Straightness* — Wires and rounds supplied in cut lengths shall be straight and free from bends and twists. The deviation in straightness shall not be more than 3 mm for a length of one metre.

5. Freedom from Defects

5.1 Iron-nickel alloys supplied in various forms and finishes shall be free from scale, corrosion, cracks, seams, scratches, slivers and other surface defects. The materials shall be uniform in cross-section, chemical composition, finish and temper.

5.2 All lubricants used in processing shall be thoroughly removed by the manufacturer. Protective coatings present on the material, as shipped, shall be readily removable by any of the common organic solvents such as trichloroethylene.

6. Grain Size — Iron-nickel alloy strips and sheets for deep drawing applications shall have an average grain size of less than 0·065 mm or 16 grains/25·4 mm^2 of image at a magnification of 100. For material less than 0·13 mm in thickness, the grain size shall be such that there are not less than 4 grains across the thickness.

7. Thermal Expansion — The average linear coefficient of thermal expansion for iron-nickel alloys shall be as indicated in Table 3 when tested with a precision Dilatometer in accordance with IS : 3410-1965 'Method of test for determining coefficient of linear expansion of metals at different temperature ranges'.

TABLE 3 THERMAL EXPANSION CHARACTERISTICS

Temperature Range, °C	Average Linear Coefficient of Thermal Expansion µm/m.°C		
	FENI 42	FENI 48	FENI 50
Typical Values			
30 to 300	4·4	8·8	10·1
30 to 400	6·0	8·7	9·9
30 to 500	7·9	9·4	10·8
30 to 600	9·6	10·4	10·8
30 to 700	10·5	11·3	11·7
30 to 800	11·4	12·1	12·5
30 to 900	12·3	13·0	13·3
30 to 1 000	13·2	13·9	14·2
Guaranteed Values			
30 to 400	5·5 to 6·5	8·9 to 9·2	10·2 to 10·7

8. Porosity — Iron-nickel alloy rounds of diameters higher than 12 mm shall be normally free from porosity when tested in a helium leak detector. Porosity requirements shall be specified by the purchasers only for critical end use applications and this shall be subject to mutual agreement between the manufacturer and the purchaser.

9. Dimensions and Tolerances

9.1 *Wires and Rounds* — The permissible variation in diameters of wires and rounds shall be in accordance with Table 4.

TABLE 4 PERMISSIBLE VARIATION IN DIAMETERS

Diameter mm		Tolerance mm
	Cold Drawn Wires in Coils	
0·05 to 0·40		± 0·008
0·41 to 1·00		± 0·02
1·01 to 4·00		± 0·03
	Cold Drawn Centreless Ground Rounds	
4·00 to 12·00		± 0·05
	Hot-Rolled Rounds	
12·01 to 25·00		± 0·10
25·01 to 50·00		± 0·25
	Forged Rounds	
Above 50·00		± 5·00

9.2 *Strips and Sheets* — The permissible variation in thickness and width of strips and sheets shall be in accordance with Tables 5 and 6.

TABLE 5 PERMISSIBLE VARIATION IN THICKNESS OF COLD ROLLED STRIP

Thickness mm	Tolerance on Thickness for Widths Under 225 mm
Under 0·15	± 0·02
0·15 to 0·40	± 0·03
0·41 to 0·60	± 0·04
0·61 to 0·80	± 0·05
0·81 to 1·00	± 0·06
1·01 to 1·25	± 0·07
1·26 to 1·50	± 0·08
1·51 to 2·00	±0·09
2·01 to 2·50	± 0·10
2·51 to 3·00	±0·12
3·01 to 4·00	± 0·15

TABLE 6 PERMISSIBLE VARIATION IN WIDTH OF COLD ROLLED STRIPS AND SHEETS

Thickness mm	Tolerance for a Given Width of		
	4·5 to 12 mm	12 to 150 mm	151 to 225 mm
Under 1·70	± 0·13	± 0·13	± 0·13
1·71 to 2·50	± 0·20	± 0·20	± 0·25
2·51 to 4·00	± 0·25	± 0·25	± 0·41

10. Hardness — Iron-nickel alloy strips and sheets intended for deep drawing applications shall be supplied in cold rolled and annealed condition. The hardness shall not exceed 82 HRB

(HV 149) for material 2·54 mm and less in thickness and 85 HRB (HV 170) for material over 2·54 mm thick when determined in accordance with IS : 1586-1968 'Methods for Rockwell hardness test (B and C scales) for steel (*first revision*)'.

10.1 Physical and mechanical properties have also been given in Appendix A for information only.

11. Packing and Marking

11.1 Wires and strips supplied in coils shall be wrapped all around with a polyethylene lined hessian cloth. The coils up to 1·5 mm wire diameter shall be packed in wooden cases to avoid damage during transit. Wires of smaller diameter supplied in spools shall be packed in polyethylene bags with small quantity of silica-gel for moisture absorption.

11.2 Rods and sheets supplied in cut lengths shall be covered in hessian and subsequently packed in wooden cases.

11.3 The wooden cases shall be indelibly marked with the manufacturer's name, mass, dimensions, batch number and description of the items.

11.4 The material may also be marked with the Standard Mark. Details available with the Bureau of Indian Standards.

12. Basis of Purchase — Order for materials under this specification shall include the following information:

a) Description and size,
b) Surface finish,
c) Packing and marking, and
d) Specification number.

APPENDIX A

(*Clause* 10.1)

PHYSICAL AND MECHANICAL PROPERTIES OF IRON-NICKEL ALLOYS

(For information only)

Sl No.	*Property*	*Unit*	*FENI 42*	*FENI 48*	*FENI 50*
1.	Density	g/cm^3	8·15	8·20	8·32
2.	Specific heat	k.cal/kg.°C	0·12	0·12	0·14
3.	Thermal conductivity	k.cal/m.h.°C	0·03	0·038	0·04
4.	Resistivity	Microhm.m	0·63	0·50	0·45
5.	Curie point	°C	350	480	520
6.	Melting point	°C	1 420	1 420	1 450
*7.	0·2 percent proof stress	MPa	380	300	290
*8.	Tensile strength	MPa	520	570	570
*9.	Elongation on 50 mm gauge length	Percent	30	29	33
10.	Hardness	HV	125-160	130-160	135-165

A-1. Weldability

Iron-nickel alloys can be welded by MIC, TIG, plasma and resistance welding. The filler rod should be preferably of the same composition for obtaining optimum joint characteristics. Heavily coated 18-8 stainless steel or mild steel filler rods can also be used. The welded parts shall be stress-relieved by annealing them at 350°C for 2 hours.

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*Properties in the annealed condition.

EXPLANATORY NOTE

Iron-nickel sealing alloys are a group of controlled expansion glass-sealing alloys having a coefficient of linear expansion matching to that of soft lead-glass and soda lime glass. Three types of iron-nickel alloys, namely, FENI 42, FENI 48 and FENI 50 are covered under this specification. FENI 42 and FENI 48 have constant rates of thermal expansion up to 345°C and 500°C respectively. FENI 42 and FENI 48 are intended for use as glass-to-metal seals in electron tubes, semiconductor, lead frames and lead wires in the manufacture of relay components, automobile lamps, bi-metallic thermostats and for shielding applications. FENI 50 finds application in glass-to-metal seals for higher than normal thermal expansion glass as well as for glass-to-ceramic seals where thermal expansion must be almost linear up to 550°C. It is also intended to be used in hermetically sealed magnetic dry reed relays and switches.

This standard has been prepared as a guide for the manufacturers and users of iron-nickel sealing alloys for obtaining the desired characteristics. While preparing this standard, necessary assistance has been obtained from ASTM-F-30-1985 Iron-Nickel Sealing Alloys and TGL 24 329-1984 Controlled Expansion Alloys Semiconductors.

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